ON POTTERY.—Part I.

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In the section of the Rules and Orders of the Society which relates to the duty of the Secretary, he is directed "as much as possible to endeavour to make himself acquainted with the nature and circumstances of the several arts and manufactures of this and other countries." In obedience to these directions, when the plan was first projected to devote a few evenings in the session to illustrate, by the exhibition of specimens, the present state of the Arts and Manufactures of Great Britain, I proposed to collect, from such authentic sources as were accessible to me, a sufficient number of particulars to explain the specimens exhibited, and to call forth discussions upon them, tending, I would hope, to the rational entertainment of those present, and occasionally to the improvement of those useful and ornamental arts that have so largely contributed to the opulence and civilisation of our country.

It never entered, however, into my thoughts, that if left to my own resources I should be at all able to fulfil the expectations of the Society: but I have had many opportunities, from my official situation, of knowing how well furnished the Society is with men personally and professionally conversant with almost every branch of manufacture. On these I knew that I could rely for all the practical information which our plan requires. I was also well aware that many of our members who rank

among the higher classes of society are in possession of rare, and curious, and interesting specimens, illustrative either of the ancient or modern state of art. Some of these treasures, I felt confident, would be offered by the liberality of their owners to the inspection of the Society. I also considered it not improbable that those public and scientific bodies, with whom we keep up an intercourse, by the mutual exchange of Transactions, and other acts of civility, would occasionally enrich our exhibitions by the loan of specimens. The Society will, I am sure, be much gratified in being informed, that whenever I have made application in their name for information or for specimens, I have not only not experienced any repulse, but all my requests have been granted with a promptitude, a kindness, and a liberality, beyond my utmost expectations. I shall hereafter have an opportunity of mentioning the names of those from whom has been derived whatever of practical information I may be able this evening to communicate; but I think it right now, upon the very threshold of our undertaking, to record the liberality of the Directors of the East India Company, who, at the suggestion of Dr. Wilkins, their librarian, have placed at our disposal such articles in their museum as may fall in with our plan. Those only who know the riches of this collection, in models, in specimens, and in products illustrative of the arts and manufactures of India and other oriental countries, can form an adequate idea of the obligation thus conferred upon us by Dr. Wilkins. To Thomas Hope, Esq., one of our members, many thanks are also due, for the valuable and extremely interesting specimens of Etruscan vases and other articles, with which he has enriched this our first exhibition.

The art of pottery, or, to use a still more general term, the manufacture of earthenware, has been selected for illustration on the present and the next succeeding evening; and if adequately treated of with regard to its history, both ancient and modern, to the physical and chemical principles on which it is founded, and to the machinery and manipulations by which its various forms are produced, as well as with reference to the connexion of these forms with the principles of fine art and correct taste, would extend far beyond the bounds within which it has been thought proper to confine it. If, therefore, some curious and important particulars are only slightly touched, or even wholly omitted, let it be remembered that, compelled as I have been to select, I have, to the best of my judgment, culled out those particulars which appeared to me most likely to interest and inform the curiosity of my audience.

Certain natural earthy mixtures, called clays, possess the property of plasticity; that is, when mixed with water so as to be sensibly moist, they yield readily in any direction to pressure without breaking, and when the pressure is removed, they retain the form given to them, without shewing any tendency to return to their original figure. When dried, by the air or by the sunshine, or by an artificial heat not exceeding that of boiling water, they acquire a certain degree of hardness; but when pressed by a force greater than their power of resistance, they give way at once, having lost their plasticity, and having become perfectly brittle. These fragments, however, when beaten up with water, compose a mass equally ductile as at first. But if the dried clay has been subjected to a red heat, its hardness is found to be much increased; and its fragments, when broken, are no more

capable of forming a mass with water than so much sand. On these two properties of clay, namely, its original plasticity, and its subsequent hardness and resistance to the action of water when burnt, the manufacture of earthenware essentially depends: the former allowing the artist easily to give to the material any figure that he pleases, and the latter giving to the ware the requisite firmness, and the capability of holding liquids, and resisting the action of most of them even when boiling hot.

Clay consists essentially of two ingredients, alumina and silica. The first of these it is which, by its combination with water, acquires that pulpy kind of consistence which fits it to be the cement of the mass; the silica is in the state of sand, more or less fine, and may be considered as the passive ingredient. If pure alumina be beaten up with water and afterwards dried, however slowly, it will be found to contract greatly in all its dimensions, and in so doing will become rifty, that is, full of cracks, and will exfoliate and fall to pieces. The addition of sand, especially in the proportion of from five to ten parts of it to one of alumina, leaves the mass still plastic, and diminishes greatly the defects which would attend the use of alumina alone. A red heat, in proportion to its intensity, produces effects on alumina similar to those which evaporation does; the mass contracts, and if it is large or thick, the heat will necessarily be unequally applied; hence arises not only a diminution of bulk, but cracks and warping from the truth of the original figure. But sand, which obviates in a great degree the former defects, also corrects these, because it is neither liable to combine with water, nor to undergo permanent contraction by heat. If, now, the natural clays

consisted merely of silica and alumina, all their varieties would depend on the relative proportion of the two ingredients, and on the coarseness or fineness of the grains of sand. The higher the heat to which alumina is exposed, the harder and more compact it becomes, so that at length it will scratch glass, and will not admit water to rise in its pores; and as the mixture of alumina and silica in any proportions is infusible in the heat of our furnaces, it is evident that a great degree of hardness may be given, by high and long-continued firing, to wares made of these ingredients, and that such ware will resist the percolation of fluids; but, at the same time, in proportion to its density will be the hazard of warping during the process of being baked.

It is, however, extremely rare to find a clay which contains only the two substances above mentioned. In general, they are mixed with lime in the state of carbonate and sulphate, with magnesia in the state of carbonate, with iron in the state of oxide or combined with sulphur, and with common salt. Almost all these compounds, or at least the bases of them, when exposed to a red heat, act chemically on one another, and on the silica and alumina. The precise nature of these actions has not been ascertained, the matter not having yet been investigated with the care that its importance deserves; but the following particulars may perhaps be considered as sufficiently authenticated.

At a moderate red heat, the iron, if neither lime nor magnesia are present, gives to the mass a more or less red colour. If lime is present in sufficient quantity, the colour given by the iron is cream-brown, passing into buff colour. If magnesia is also present (for I am not acquainted with any clay that contains magnesia without

lime), the colour of the ware is brownish yellow, or the colour of unburnt ochre.

The carbonate of lime loses its carbonic acid, which escapes in the form of gas through the pores of the ware, provided the carbonate is thoroughly mixed with the other ingredients; but whenever a lump of it, even no bigger than a pea, occurs, a hole reaching to the surface is generally produced, probably by the rapid escape of the gas. Another effect produced by the lime is, that it combines with the alumina; and if the former is equal in quantity to the latter, it greatly diminishes, and, according to Bergman, almost entirely prevents the contraction of the alumina. At a more intense heat, the lime, the sand, and the alumina, melt together into an imperfect glass or slag, which, as it is formed, dissolves the oxide of iron, and thus acquires a bluish black or greenish blue colour. The common salt is also decomposed; and the soda, which is its base, assists the action of the lime. The magnesia, sometimes at least, combines with sulphuric acid, which it gets partly from the iron pyrites mixed with the clay, and partly from the fuel, when coal is made use of. This sulphate of magnesia it is which is occasionally found to cover the outer surface of new-built walls with a saline efflorescence, like hoar frost.

Having now stated the general principles on which the manufacture of earthenware depends, I proceed to give some account of the principal varieties of it. These I shall arrange in groups, characterised for the most part by the greater or lesser elaborateness of the process employed in the preparation of the ingredients, and the beauty, the fineness, and commercial value of the ware itself.

The coarsest and most simple kind of earthenware is that employed in the walls and as the covering of houses and other buildings: of this there are two kinds, bricks and tiles.

The manufacture of bricks goes up to the very earliest time of historical record. In the book of Genesis, Nimrod is stated to have been the first sovereign, and to have reigned in the land of Shinar, one of the towns of which was Babel. The first building after the flood, of which any mention is made, was the Tower of Babel. It is expressly stated that well-burnt brick was used instead of stone in these constructions; and that slime, which is generally understood to be bitumen, was employed instead of mortar. Considerable progress appears to have been made in building both the city and the tower before what is called the confusion of tongues took place, in consequence of which the work was abandoned. Nearly on the same site was afterwards founded the celebrated city of Babel, or Babylon; which is described by Herodotus, the oldest Greek historian, as surrounded by a deep and wide trench, the earth from which was formed into bricks. These bricks were then burnt in furnaces or kilns, and were employed part in lining the trench, and the remainder in building the walls: the cement used was hot bitumen, and between every thirty courses of bricks was a layer of mats composed of reeds. The ruins of Babylon are still visible, in the form of hillocks or high mounds, and have been visited of late years and described by several travellers. The late Mr. Rich appears to have examined these remains with great care, and from his memoir the following particulars, as far as relates to our immediate subject, are derived. Most of the mounds

appear to have a certain degree of connexion with one another; but the largest of the mounds, the Birs Nemrood, together with another adjacent, called Akerkouf, is so far distant from the others as to render it doubtful if it could have been included within the extent of the Babylon described by Herodotus.

The connected mounds present walls and passages, or galleries, formed of well-burnt brick, laid in lime-mortar of extreme toughness; but in one of them, called the tower of Belus, large solid masses, or fillings up between the wall, are observed of unburnt bricks. These latter are more rudely shaped than the burnt bricks, being rather clods of earth, composed of a kind of clay-mortar, intermixed with chopped straw to prevent it from falling to pieces: these unburnt bricks are laid in very thick cement of clay, with layers of reeds above the courses of brick.

The Birs Nemrood, so called no doubt after Nimrod, is at present a mound 762 yards in circumference and 198 feet high; it consists of three steps, or receding stories: the interior of the mass appears to consist of layers of unburnt bricks set in clay, sometimes without layers of reeds, sometimes with them, laid between every five or six courses of bricks. This mass is in some parts faced (and probably when perfect was completely so) with layers of burnt bricks set in bitumen. These bricks are about thirteen inches square by three inches thick, and have indented inscriptions, apparently made by a stamp, in a character at present wholly unknown, the elements of which appear to have been representations of arrows variously combined together. The bricks are laid with the written face downward, so that they were not visible on the front of the wall. At the top of the mound is a

solid pile, thirty seven feet high, of burnt bricks, with inscriptions, and set in lime-mortar.

From the proportions of the three stories that now remain, it seems probable that the mound or pyramid consisted, or perhaps was intended to consist, of five stories; the three lower of which were solid, and the two upper would probably have contained chambers. Whether this pile is the unfinished tower of Babel or not, is at present only matter of conjecture: its local situation with regard to the other mounds is rather in favour of the hypothesis; and the specimens of bricks now produced, which were obtained from this very mound, will be regarded with no small interest: they form part of the collection of the East India Company.

The manufacture of bricks was also known to the ancient Egyptians. Every body is aware that one of the modes of oppression practised by this people towards the Israelites, was the unreasonable requisition from them of a certain number of bricks: it is not mentioned that these bricks were burnt; indeed, the circumstance of their being mixed with chopped straw, like the unbaked bricks found in Babylon, renders it probable that they were only sun-dried. Herodotus also records of Asychis, one of the kings of Egypt, that he built a pyramid of bricks made of the mud or silt dredged up from the bottom of the river. This is perhaps the same as that now called the pyramid of Meidun: it was visited by Pococke, and is described by him as formed of unburnt bricks, composed of a mixture of clay and chopped straw. Such unburnt bricks, Pococke adds, are still used in Egypt. It is probable that in the time of Pliny the elder, who lived in the reign of Vespasian, unburnt bricks were in use elsewhere on the north coast of Africa; for that author

mentions, that at Utica no bricks were allowed to be used that had not been dried five years in the sun; a regulation which apparently would be absurd if applied to baked ones. But sun-dried bricks may rather be considered as a kind of artificial stone than earthenware; and, from the circumstance of chopped straw being mixed with them, the clay was probably much more sandy and less tenacious than that required for burnt bricks, and approached nearly to the loam employed at present in building walls by ramming, or *en pisé;* a mode of construction which also was well known to the ancients; Hannibal having constructed several towers on the coast of Spain of this material.*

Certain other celebrated buildings of high antiquity were also formed of brick: such were the palaces of Crœsus at Sardis, of Mausolus at Halicarnassus, and of Attalus at Tralles; all of which were still remaining in the reign of Trajan. That part of the walls of Athens which looks towards Mount Hymettus, as well as some of the more ancient temples in that city, were also built of brick.

In ancient Rome, if the recorded saying of Augustus, that he found the city of brick, and left it of marble, be of any authority, the public buildings must have been generally of baked brick; but this material does not seem to have been much employed in the construction of private houses, many of which were of wicker-work, covered

* Quid? non in Africâ Hispaniâque ex terrâ parietes, quos appellant formaceos, quoniam in formâ circumdatis utrimque duabus tabulis, inferciuntur veriùs quàm instruuntur, ævis durant, incorrupti imbribus, ventis, ignibus, omnique cæmento firmiores? Spectat etiam nunc speculas Hannibalis Hispania, terrenasque turres jugis montium impositas.—*Plin. Hist. Nat.* xxxv. 48.

with clay, raised on low walls of unbaked bricks. Whenever works were erected by the Romans of rough unsquared stones, they were in the habit of interposing occasional courses of flat thin bricks, to strengthen the building and to keep it upright. Many such examples are to be found in our own country, where permanent Roman stations occur. The walls of Richborough near Sandwich, the tower supposed to have been a light-house on the summit of Dover castle, the station of Garrienum (now Borough camp), at the conflux of the Yare and Waveney in Norfolk, are among the most perfect and remarkable. All the Roman bricks that I have seen are of a deep red colour, very compact, and well burnt. They probably were composed of natural clay, not containing lime, and merely sifted, either dry or by washing over, in order to separate the stones and coarser sand.

In Bengal, and generally in the wide alluvial valley of the Ganges, bricks are the usual material for buildings of any solidity; and they appear to have been used in this country from very high antiquity, and to have been employed even in the ornamental parts of architecture.

In Nipal, a hilly country north of Bengal, bricks are made of remarkable compactness of texture: they are of a brownish-red colour, and are very micaceous; so that the clay of which they are formed has probably originated from the decomposition of granite. Some of these, from the East India Company's museum, are now before the Society. Not only the texture of these bricks, but the elegance of their ornamented surface, deserve notice; the sharpness and depth of cutting are such as to make it probable that they were moulded plain, and that the ornaments were afterwards cut, before the process of burning.

In China, bricks are made of blue clay more or less sandy: the specimens before the Society have evidently not been burnt; they nevertheless do not disturb the clearness of water after lying in it for many hours. When burnt they become of rather a pale red, with a compact, almost semi-porcelainous texture.

I am not sufficiently acquainted with the history of the art of brick-making to state to you the date and particulars of its introduction into the different countries of modern continental Europe. It was certainly practised largely in Italy in the beginning of the fourteenth century; and Mr. Hope informs me, that the brick buildings erected at this period in Tuscany, and other parts of the north of Italy, exhibit at the present day the finest specimens extant of brick-work. In Holland and the Netherlands, from the scarcity of stone, brick was used at an early period, and to a great extent, to supply the wants of a dense and rich population.

In England, from the time of the Romans to the middle of the fourteenth century, brick seems to have been entirely unknown, or at least unemployed. Soon afterwards, the wooden palace at Croydon was rebuilt, and two sides of the great court were formed of brick, which is considered by Dr. Ducarel as the first modern instance of the use of this material in England. It was not, however, till a considerable time subsequent that the employment of brick became common; for Holinshed, in the introduction to his "History of Queen Elizabeth," enumerating the materials employed at that time for building houses, omits all mention of brick.

Till lately, bricks appear to have been made in this country in a very rude manner. The clay was dug in the autumn, and exposed to the winter frost to mellow;

it was then mixed, or not, with coal ashes, and tempered by being trodden with horses or men, and was afterwards moulded, without it being considered necessary to take out the stones. The bricks were burnt in kilns or in clamps: the former was the original mode, the latter having been resorted to from motives of economy. When clamps began to be employed I do not know; but they are mentioned in an act of parliament passed in 1726, and therefore were in use prior to that date. The following, in few words, is the present process of brick-making in the vicinity of London, for the practical particulars of which I am indebted to Mr. Deville and Mr. Gibbs.

It is chiefly, I believe entirely, from the alluvial deposits above the London clay, that bricks are made in the vicinity of the metropolis; and a section of these deposits generally presents the following series, such as would naturally result from a mixture of stones, and sand, and clay, and chalk, brought together by a torrent of water, and then allowed to subside. The lower part of the bed is gravel, mixed more or less with coarse sandy clay and pieces of chalk; this by degrees passes into what is technically called malm, which is a mixture of sand, comminuted chalk, and clay; and this graduates into the upper earth or strong clay, in which the clay is the prevailing or characterising ingredient, the proportion of chalk being so small that the earth makes no sensible effervescence with acids. Bricks made of the upper earth, without any addition, are apt to crack in drying, and in burning they are very liable to warp, as well as to contract considerably in all their dimensions: on this account they cannot be used for the exterior of walls; and a greater number of such are required for any given quantity of work than

of bricks, which, though made in the same mould, shrink less in the baking. The texture, however, of such bricks is compact, which makes them strong and durable. Bricks formed of this clay, whether mixed or unmixed, are called stocks; it was formerly used unwashed, and when the bricks were intended to be kiln-burnt, or flame-burnt, to use the technical word, no addition was made to the clay. If they were intended to be clamp-burnt, coal-ash was mixed during the tempering. Of these and all other clamp-burnt bricks the builders distinguish two kinds, namely, the well-burnt ones from the interior, and the half-burnt ones, or place bricks, from the outside of the kiln.

At present the clay for stock bricks is separated with tolerable care from the pebbles, and its tendency to shrink and warp is diminished by the addition of chalk ground to the consistence of cream; but the calcareous earth increases the liability of the brick to vitrify in the burning, to counteract which, more sand is added. By these successive additions, however, the compactness of the texture is diminished, and such stock bricks approach nearly to the quality of malm bricks. Sometimes, instead of chalk and sand, malm earth and ashes are added.

The calcareous clay or malm earth requires no addition of sand or chalk, but only of ashes. The bricks made of it differ from those made of the top earth, in being of a pale or liver brown colour, mixed more or less with yellow, which is an indication of magnesia; and such bricks are liable to effloresce. The hardest of the malm bricks are of a pale brown colour, and are known by the name of grey stocks; those next in hardness are called seconds, and are employed for fronts of the better kind of houses; the yellowest and softest are called cutters, from the

facility with which they can be cut or rubbed down, and are used chiefly for turning the arches of windows. What I have said of top earth and malm earth must be understood, however, to refer to well-characterised samples of these varieties, but, as might be expected, there are several brick-fields that yield a material partaking more or less of the qualities of both, and therefore requiring corresponding modifications in its manufacture.

Brick earth is usually begun to be dug in September, that it may have the benefit of the frost in mellowing it and breaking it down. It is then washed by grinding with water, and passed through a grating in order to separate the stones; the mud runs into shallow pits, and here is to be mixed with ground chalk, if any is required: when it has become tolerably stiff by drying, coal-ash is added, usually in the proportion of one foot in depth of this latter to three feet of clay; the ingredients are then to be well mixed; and, finally, the composition is to be passed through the pug-mill, in order to complete the mixture and to temper it. The moulder stands at a table, and the tempered clay is brought to him in lumps of about 7 or 8 lbs.: the mould is a box without top or bottom, $9\frac{5}{8}$ inches long, $4\frac{3}{4}$ wide, and $2\frac{3}{4}$ deep; it lies on a table: a little sand is first sprinkled in, and then the lump of clay is forcibly dashed into the mould, the workman at the same time rapidly working it by his fingers, so as to make it completely close up to the corners; next he scrapes off with a wetted stick the superfluous clay, shakes the brick dexterously out of the mould on to a flat piece of board, on which it is carried to a place called the hacks; here it remains till dry enough to handle, and is then formed into open hollow walls, which are covered with straw to keep off

the rain, where it dries gradually, and hardens till it is fit to be burnt. A raw brick weighs between 6 and 7 lbs.; when ready for the clamp it has lost about 1 lb. of water by evaporation.* A first-rate moulder has been known to deliver from 10,000 to 11,000 bricks in the course of a long summer's day, but the average produce is not much more than half this number. If, however, the average daily produce of one moulder be estimated only at 5000 bricks, it is quite evident that the project of moulding them by expensive machinery, complicated, and therefore liable to want frequent repairs, cannot but be a most ruinous speculation.

The consumption of London is chiefly supplied from the brick-fields north of the Thames, at Stepney, Hackney,

* From some experiments made in France we learn the following particulars:—A mould 8 inches 3 lines long, 4 inches 3 lines broad, and 2 inches 2 lines thick, yielded bricks which on an average weighed, when first made, 5 lbs. 14 oz. When dried and ready for the kiln they weighed 4 lbs. 8 oz., having lost 22 oz. of water: 9 oz. of this quantity evaporates in the first twenty-four hours, the other 13 oz. require five or six weeks to evaporate. By burning, 4 oz. more of volatile matter is driven off; a well-burnt brick of the above dimensions weighing 4 lbs. 4 oz. A fresh-burnt brick when laid in water absorbs about 9 oz., *i. e.* from one-seventh to one-eighth of its weight.

It appears, however, from experiments by M. Gallon, that the weight of bricks varies according to the care with which the clay is worked or tempered. Some clay was well worked, and then beaten for half an hour, on the morning of the next day it was again worked and beaten as before, and in the afternoon was again beaten for a quarter of an hour, and was then made into bricks. Another parcel of bricks was made of some of the same clay, treated in the usual manner. Both parcels were dried in the air for thirteen days, when it was found that those made by the former process weighed on an average 5 lbs. 11 oz. each, while those made by the latter weighed 5 lbs. 7 oz. Both kinds were burnt together for ten days; they underwent no relative change in bulk, but the weight of the former was 5 lbs. 6 oz., and of the latter 5 lbs. 2 oz.—*Arts et Métiers*, vol. iv.

Tottenham, Kingsland, Hammersmith, Cowley, Acton, and Brentford. Those made at Grays Thurrock, Purfleet, and Sittingbourne, are of a very good quality and a fine yellow colour; stone-coloured ones are made near Ipswich, and have been largely employed in the outside walls of some of the new churches of the metropolis. There is a considerable exportation of bricks from London; many being sent to the West Indies, to Quebec, and to other colonies.

Tiles, from the purpose to which they are applied, namely, the roofing of houses in order to shoot off the rain, require a texture as compact as can be given to them, consistent with a due regard to economy. The fattest and most unctuous clays are, therefore, those which answer the best, especially if free from gravel and the coarsest sand. The price of tiles, compared with that of bricks, is such that the manufacturer can afford to dry them under cover; while, being not more than one quarter of the thickness of bricks, the drying is more speedily performed, and with far less hazard of warping or cracking: the same also is the case with the baking. Sand is added to the clay, but sparingly; for if, on the one hand, it prevents the ware from warping, yet, on the other, it increases the porosity, which is a fault especially to be avoided. The general manipulations of grinding the clay and tempering it are analogous to those already described for making bricks; but more pains are bestowed in getting it to the utmost degree of plasticity, so as to allow of its being rolled, like dough, into cakes of a proper thickness, which are afterwards brought to the required shape by pressing them into a mould.

The material employed at the manufactories of tiles in the neighbourhood of London is either the bed of blue clay, called by geologists the London clay, or the plastic

clay which lies below the former. The tileries north of the Thames, at Hackney, Clapton Terrace, Hornsey, and Child's Hill near Hampstead, are on the London clay; those near Woolwich are on the plastic clay. The same clay answers well for sugar-cones, for garden pots, and all articles of common red ware that do not require to be glazed, and in which a certain degree of porousness is no objection to their use.

If well-tempered clay be placed on a horizontal board, to which, by any simple machinery, a movement of rotation on its centre is given, it is evident that a tendency to centrifugal motion will be communicated to the clay, which, though not of itself sufficient to overcome the tenacity of the earth, will extremely facilitate the action of the fingers in forming out of the mere lump either solids or hollow vessels, of every conceivable variety, consistent with the condition that the section of such vessels in any part at right angles to the axis shall be a circle. The board above described is called the potter's wheel or lathe. By whom it was invented is not known; for in the most ancient records it is spoken of as an implement familiar to every one. The potter's wheel is frequently mentioned in the Jewish writings;* and Homer, the most ancient of the Greek authors, has a comparison the subject of which is a potter turning round with his hands a newly fitted wheel to see if it runs true.† In India, where im-

* "I went down to the potter's house, and behold he wrought a work on the wheel; and the vessel that he was making of clay was marred in his hands; so he made it again into another vessel, as seemed good to the potter to make it."—*Jerem.* xviii. 3.

† ——— ὡς ὁτε τις τροχον αρμενον εν παλαμησιν
Ἑζομενος κεραμευς πειρησεται αἰ κε θεησιν.—*Iliad*, xviii. 600.

As some potter, seated, tries with his hands the well-fitted wheel whether it will run.

plements and tools for the manufacturer are reduced to their utmost possible degree of simplicity, the potter squats on the ground, turning the wheel on its spindle with his feet, while he moulds the clay with his hands. In this country, and I believe in general throughout Europe, the workman turns the wheel by a treadle, as he sits or stands to his work; and, when the article to be made is large and heavy, the motion is given by an assistant working at a vertical wheel. In large establishments, where many of these wheels or lathes are in use, a steam engine is generally employed as the prime mover. It is impossible to describe by words the facility and quickness with which the clay obeys the hand of the workman and takes the figure required; it must be seen in order to be truly judged of; and few processes are more entertaining to the by-stander, because there are none in which the effect more immediately follows the application of the cause, and in which the material is so completely under the control of the workman, adapting itself to his taste, his whim, his caprice; in which the form that has been just given may be annihilated by a touch, and the material may be immediately made to assume its former, or a wholly different figure. No wonder, therefore, that "clay in the hand of the potter," is so often and so impressively used to denote the relative situations of man and of Him who guides and moulds our purposes at his pleasure.

I shall now proceed to give a brief account of the manufacture of the common red pottery ware, as practised in the neighbourhood of London, and in various other parts of the kingdom; for the principal particulars of which, as well as for the specimens in illustration of it, I am indebted to Mr. Jones, of Lambeth. The material

is a yellowish brown clay, from Deptford, there being no other near London on which the glaze will spread with the equality that is required. In general the clay is used without any addition; but such parcels as are too fat or tenacious are brought to a proper state by mixture with loam. The clay is watered and turned, but not being an alluvial clay, contains no stones, and therefore does not require to be washed over. It is finally passed through the pug-mill in order to temper it. The required form of a pot or pan, or any other article, is given to it on the wheel, and the ware is dried under cover till it has acquired a considerable solidity. The glaze is then put on in the state of cream, by means of a brush, care being taken to cover the whole surface as evenly as possible: for small articles, such as pipkins, that are glazed only internally, a little of the cream is poured in and then poured out again, a sufficient quantity of the glaze adhering to the bibulous surface of the ware.

The materials of the glaze are galena, commonly called potter's lead ore, ground to an impalpable powder, and then mixed with clay diffused in water, technically called slip. This glaze is transparent, and of a pale yellow colour, and consequently shews through it the colour of the ware; if a black opaque glaze is required, one part of common manganese is added to nine parts of galena. After the glaze is laid on, the ware is again dried, and is then piled in the kiln in order to be burnt or fired. For the first twenty-four hours a very low heat is applied, in order to drive all the moisture out of the ware; it is then exposed for twenty-four hours more to a heat as high as it can bear without fusion, which has the effect of baking the clay, of driving off the sulphur from the lead ore, and of causing the oxide of lead to form a frit or

imperfect glass with the clay, the other ingredient of the glaze. The fire is now fed with bavin wood instead of coal, by which the heat is increased, the furnace is filled with flame, and the frit being converted into a perfect glass, flows uniformly over the surface of the ware. The fire is then allowed to go out, and when the furnace has become cool, the contents are removed. If the air has been still during the burning, and due care has been observed, the articles in every part of the kiln will be properly baked; but a high wind always renders the heat very unequal, so that the ware in the windward part of the kiln will not be baked enough, while that in the leeward part will be over-burnt and run to a slag.

All articles of earthenware which after being baked are opaque, are more or less porous; and if a heat somewhat approaching to their point of fusion, so as to render them slightly translucent, cannot safely be applied, it is evident that such ware is not very proper for vessels employed in cookery, and for several other purposes, from the difficulty of keeping them clean, and from their liability to crack when set on the fire in a damp state. In England, we endeavour to obviate this imperfection by means of a thick vitreous glaze; but as the ware itself is very fusible, the glaze must be still more so; and as oxide of lead forms the cheapest and most fusible glaze, this accordingly is the material universally employed by us. But there is a very serious objection to the use of this glaze, namely, that it is soluble in vinegar, in the juice of most fruits, especially when hot, and also in boiling fat; the consequence of which is, that the food of the lower classes, by whom alone cooking vessels of glazed red ware are employed, is often contaminated with lead, so as seriously to impair their health by occasioning

colics, and the other usual effects of lead poison. Possibly borax, which is now a cheap article and is very fusible, might be made to supersede the use of lead; if not, the only way of avoiding this very serious hazard to health will be the use of more refractory clay, which, consequently, would allow the employment of a less fusible glaze free from lead. This has been done by Mr. Meigh, a potter in Staffordshire, to whom the Society awarded a medal for his invention: the ware produced by him is far superior to that in common use, and well deserves the encouragement of the public. The natives of Peru, as Captain Bagnold informs me from his own personal observation, are in the habit of rendering their earthenware impermeable by water, by rubbing it when hot with tallow, which being partly charred, fills up the pores, and at the same time gives the ware a black colour, of which the specimens now before you are examples. The Etruscan and Greek vases are covered by a black carbonaceous non-vitreous varnish, which evidently wears off by long handling, and may probably have been produced by a process similar to the Peruvian. The pottery of Samos, which was in great request among the ancients, especially for cooking vessels, has a red covering, seemingly semi-vitreous. Wine and oil jars were rendered by the ancients impenetrable to moisture, as they are at present by the people of Spain and Italy, by rubbing them with wax; but for holding dry substances no glaze or varnish was required. Statues of the gods were in Rome very generally made of terra cotta,* that is, of red ware, till the conquests of Sylla, Lucullus, and Pompey, by their large introduction of Greek statues of marble, changed the

* "Fictilibus crevêre Deis hæc aurea templa."—*Propert.* iv. 1, 5.

fashion. Other uses of red ware among the Romans were for tiles and water-pipes; and Pliny states, that M. Varro and others directed that their bodies when dead should be deposited in earthenware.* A species of ware, somewhat superior to our common red ware, is made at Lambeth, of Maidstone clay, being of a paler colour and a more compact texture than the latter, but does not take a uniform covering by the common glaze for red ware; it is therefore chiefly used for purposes which admit its employment in an unglazed state, or in situations where the imperfection of the glaze is not perceived, as in ornamented chimney-pots, gas-consumers, &c.

A more perfect, and indeed very excellent species of earthenware, is that called stone ware, originally introduced from Holland, and now made in several parts of the kingdom, and especially at Lambeth. To one of the principal manufacturers of this ware, Mr. Wisker, I am indebted for the specimens on the table, and for the following particulars.

The materials are, pipe-clay from Dorsetshire and Devonshire, calcined and ground flint from Staffordshire, and sand from Woolwich and Charlton.

The clay is pulverised and sifted dry, and is either used alone, when an article of great compactness is required, as soda-water bottles, or is mixed with sand to diminish its contraction in the fire. For retorts and other large vessels, instead of sand, the refuse stone ware, ground to a fine powder, is used. For the finer articles, such as figured jugs, ground flint is employed in place of sand. The composition is brought, by the addition

* Hist. Nat. xxxv. 46.

of water, to the state of mortar, and is then tempered in the pug-mill. All round articles are made on the horizontal wheel; and those of great size, *i. e.* of a greater capacity than two gallons, are at first of extraordinary thickness below to support the upper part; when they come off the wheel they are dried, and then put on the wheel again, and shaved down to a proper thickness. For oval, and other figures not circular, as pans for salting hams in, the clay is formed in a mould to the required shape. The drying, especially of large articles, must be very carefully performed; and as, from custom, the tops or bottoms of jars and various other vessels made of this ware are required to be of a deeper brown than the natural colour of the materials, they are dipped in a mixture of red ochre and clay slip. When perfectly dry they are piled in the furnace, bits of well-sanded clay being put between each piece to prevent them from adhering. A slow fire is kept up for twelve to twenty-four hours, according to the thickness of the ware, capable of bringing it just to a low red heat. The fire is then to be raised till the flame and the ware are of the same colour, and is so to be continued for several hours. At this time the glaze is added, which is done by pouring down the holes in the top of the kiln, twenty or thirty in number, ladlesful of common salt. This, being volatilised by the intense heat of the interior, attaches itself to the outer surface of the ware: here it is decomposed, the muriatic acid flying off, and the soda remaining behind in union with the earth, with which it forms a very thin, but, on the whole, a perfect glaze; at least quite sufficient, with the compactness of the ware, to render it completely proof against the percolation, not only of water, but of the strongest acids. So perfect,

indeed, is the texture of the best ware now made, that it has of late been very largely used in the construction of distillatory vessels for manufacturing chemists, instead of green glass, as being more durable and also cheaper. Pickling jars, and many other vessels in which acid substances for food or condiment are kept, as also those earthen vessels in which great strength is required, are best made of stone ware. Vauxhall is the chief seat of this manufacture. There are now about eight houses engaged in this fabric, most of which are very actively employed, as the use of it is considerably on the increase.

ON POTTERY.—PART II.

Read Feb. 10, 1829.

The ancient Greeks appear to have been wholly unacquainted with the art of covering earthenware with a vitreous glaze; at least neither Pliny, nor other authors whom I have consulted on the subject, say any thing about it, nor am I aware that any specimens of glazed ancient Greek or Roman pottery exist. For heating water and other liquids in, metallic vessels were generally, perhaps universally, employed; and although cold liquids were kept and conveyed in earthen vessels, the natural porousness of the ware was corrected by a varnish of wax or resin, or it was covered with a thin, black, non-vitreous varnish, one method of producing which I have already pointed out. It may be seen on all the so-called Etruscan vases; and from these was liable to be worn off by

long use, as evidently has happened with the lower part of the vase belonging to Mr. Hope, which was exhibited at our last meeting.

Vitreous glazes, whether employed simply for closing the pores of baked clay, and thus rendering it impermeable to water, or with the farther intention of concealing the coarseness and bad colour of the body by a covering of enamel, appear to have originated in China; for the earliest European travellers in that country make mention of temples covered and encrusted by varnished tiles of various colours.

The invasion and conquest of China, by Zengis Khan, in 1212, was probably the event that made known to the rest of Asia and to Europe the art of glazing earthenware. The empire of Zengis extended from China across the steppes or pastoral regions of Asia to the Caucasus, between the Black Sea and the Caspian, and his son Octai pushed through Russia into Poland, and the confines of Germany. They likewise, in their victorious progress, held hostile or friendly intercourse with many of the Mahometan sovereigns who possessed the countries to the south and west of them; and the whole Mahometan world, though broken into independent, and frequently conflicting states, was nevertheless pressed into close union by the crusades, which had hardly yet subsided, and by the now imminent hazard of Tartar conquest. The Moslems were also at this time not only a warlike, but an active, ingenious, splendid, and inquisitive people, possessing a language, the Arabic, in a great measure common to all who professed the faith of Mahomet. The similarity of their architecture, in the wide extent of country from the Ganges to Gibraltar, shews not only a coincidence of feeling, but a community of intercourse.

It appears, therefore, to me by no means improbable, that an invention, which was largely and generally applied to decorative purposes in Mahometan architecture, should have travelled in a few years from the confines of China to Spain.

The palace of the Moorish kings at Granada, called Alhambra, was built in 1280, and many of the rooms are represented as ornamented by lacquered tiles. The tomb of Sultan Mahomed Khoda-Bendeh, at Sultanieh, in Persia, was also built in the thirteenth century; and of this, the cupola and minarets are still in many parts covered with a green lacquered tile, and the great architrave is formed of a dark blue one.

In 1475 was built the painted mosque, in the now ruined city of Gour, in India: it derived its name from the profusion of glazed tiles with which it was ornamented; specimens of which, from the East India Museum, are now before you.

The mother of Shah Abbas, about 1550, built a caravanserai at Mayar, near Ispahan, the front of the principal gate of which is inlaid with green tiles; and at present the domes of the mosques of that city are covered with green and blue tiles.

Marco Polo, the Venetian, visited, in 1270, the court of Kublai Khan, the grandson of Zengis, and remained in the employ of that sovereign for several years; at the same time merchants from many of the commercial cities of Italy were travelling, for the purpose of trade, in most of the countries between Syria and India. By some of these, the art of covering baked earthenware with an opaque vitreous glaze might be imported into Italy; and Florence and its territory soon became celebrated for the fine works executed on plates of this ware, which met

with a ready sale through Europe. The name given in France to these works was *faience*, supposed to have been derived from Faenza, a village near Florence, or perhaps the word is a mere corruption of Firenze, the Italian name of that city. Tiraboschi mentions one "Luca della Robbia, a Florentine, born in 1388, who appears to have been the first who made figures of terra cotta, and covered them with a varnish, to preserve them from the injuries of time and weather. He also adorned flat surfaces of terra cotta with various colours, and painted figures on them, by which he rendered himself so famous that he received orders for them from all parts of Europe."

Another artist, of the same name as the preceding, and possibly a descendant of his, is described by Vasari, (*Vite de' Pittori*, lib. i. p. 202), as having been introduced by Raffaello to the favour of Leo X. He is stated to have carried to high perfection an art long practised by his ancestors, that of painting on *terra invitriata* (glazed earth). In this manner he executed the *impressa* or arms of Leo X., which yet adorn the apartments of the Vatican.

Raffaello himself is said in his youth to have painted, or at least to have given designs for painting, in enamel on glazed earthenware. Such works are commonly known by the name of Raphael china, two interesting specimens of which, from the collection of R. H. Solly, Esq., are now before you. From some casual flaws in the back of these plates, it may be seen that the body of them is red earthenware in one, and grayish brown in the other, and of rather a coarse quality. Mr. Windus also has sent a plate, doubtless of Italian manufacture, bearing the date of 1533, thirteen years after the death

of Raffaello. He has also sent a singular specimen of a somewhat similar ware, but with the figures in high relief, and far inferior to the former as a work of art.

Mr. Brockedon informs me that, in his journey among the Alps last year, he saw some beautiful specimens of Raphael china, in the possession of the hostess of an inn at the village of Rauris, in Carinthia. They consisted of three dishes; the subjects painted on them are, Pan and Apollo, Jupiter and Semele, and on the largest, Apollo surrounded by wreaths of nymphs and satyrs, and on the rim are entwined Cupids: this latter dish is about twenty inches in diamater, and bears an inscription, in Italian, purporting that it was made at Rome, in 1542, in the manufactory of Guido di Merlingho Vassaro, a native of Urbino. The date is twenty-two years after the death of Raphael; but, as the manufacturer was a fellow-townsman of that celebrated artist, the inscription, taken in connexion with the anecdote of Vasari already mentioned, is interesting, as throwing light on the association of the name of Raffaello with this species of ware.

Whether a less ornamented or plain variety of glazed pottery was at this time made in Italy for common table service, I do not know. It is probably from Italy that Holland received this art. The Venetians, the Genoese, and the Florentines, had very extensive commercial dealings with the merchants of Antwerp and of other towns in the Low Countries; it is therefore extremely likely that the potters of Holland, to whom is due the first fabrication of clay tobacco-pipes of excellent quality, derived their knowledge of glazed ware from this source. The town of Delft was the centre of these potteries, in which were fabricated the tiles known in England by the name of

Dutch; and the delft were employed for table service, and for other domestic purposes. Considered merely with regard to its material, the Dutch potters seem to have improved on their Italian originals, being probably instigated by a comparison with the blue and white patterns of Nankin, which was now largely imported by the Dutch from China and Japan, and which is a coarse, yellowish, porcelain body, covered by an opaque white glaze. In the ornamental part, however, the Dutch fell immeasurably short of the potters of Florence: blue seems to have been the only colour employed by them; and their favourite patterns appear to have been either copies of the Chinese, or European and Scripture subjects treated in a truly Chinese manner and taste.

It is about two hundred years ago since some Dutch potters came and established themselves in Lambeth, and by degrees a little colony was fixed in that village, possessed of about twenty manufactories, in which was made the glazed pottery and tiles consumed in London and in various other parts of the kingdom. Here they continued in a flourishing state, giving employment to many hands in the various departments of their art, till about fifty or sixty years ago; when the potters of Staffordshire, by their commercial activity, and by the great improvements introduced by them in the quality of their ware, in a short time so completely beat out of the market the Lambeth delft manufacturers, that this ware is now made only by a single house, and forms the smallest part even of their business. Mr. Wisker, a member of the Society, is the potter to whom I allude, and from his liberality I have derived the specimens and details of the manufacture, which I shall now proceed to lay before you.

The articles of delft ware, for which there still continues to be an effective demand, are plain white tiles for dairies and for lining baths, pomatum pots, and a few jugs, and other similar articles, of a pale blue colour.

The material employed is calcareous clay, or marl, of a blue, red, or yellow colour, from the neighbourhood of Maidstone, and therefore probably belongs to the deposit called the Weald clay, which lies below the green sand. The first process which it undergoes is that of grinding with water, and passing it in this state over fine sieves, in order to separate the coarser particles. The excess of water is then dried off by exposing the fine mud to spontaneous evaporation in shallow tanks or pits. While still in a soft state it is beat up by hand, and then heaped up in a cave or clay cellar (as it is technically called) till wanted. The longer it remains here, the more tenacious and plastic it becomes. It is then tempered for use by passing it through a pug-mill, or is kneaded by treading; the addition of sand of every kind being carefully avoided. The ware is formed in the usual way, then dried, and afterwards placed in the arch of the kiln to burn into biscuit. It is now of a pale buff colour, the lime in the clay having combined with the oxide of iron, and thus preventing it from exhibiting the red colour which is natural to it, and which it possesses when combined with sand or with mere clay. The glaze is thus formed: Kelp and Woolwich sand are calcined together under the kiln till they combine into a spongy imperfect glass or frit; lead and tin are calcined together till they form a grayish white powdery oxide, called by the potters tin and lead ashes; the frit is then ground dry, and afterwards mixed with the ashes, a little zaffre being added if a blue tint is required, and arsenic if the glaze is intended to be

white. The composition being well mixed dry, is put in the hottest part of the kiln, where it runs into a vitreous opaque enamel. This latter is then ground under a heavy runner of iron, and is finally mixed with water, and rubbed between stones to the consistence of cream. The biscuit, rendered bibulous by drying, is then dipped in this cream, and a sufficient quantity of glaze adheres to the surface of it. The ware is next dried, packed into saggars, which are boxes of clay, to prevent it from being injured by the smoke; and these saggars are piled in the kiln. A heat moderate for the first twelve hours, and stronger for the last twelve hours, is applied, which vitrifies the glaze on the surface of the ware, and thus completes the process.

As the use of delft pottery was superseded by the earthenware of Staffordshire, it might seem more natural for me to pass to the description of this latter, rather than to the subject of porcelain. But the European imitations of the Chinese porcelain have introduced so many modifications in the manufacture of the finer kinds of earthenware, that the line of distinction between them has become almost evanescent; and I think it will conduce to the clearer understanding of that part of my subject which yet remains to be illustrated, if I begin with the porcelain of China.

It had never entered into the head of any one that the ancients were acquainted with porcelain, till the learned Jos. Scaliger expressed his opinion, that the murrine cups brought to Rome by Pompey, after his conquest of Asia Minor, were of porcelain from China. The opinion of Scaliger has, however, been adopted by Salmasius and other critics, as well as by the late Dr. Vincent, in his commentary on the Periplus of Arrian; so that, although critical disquisitions may seem out of place on the present

occasion, I hope to be indulged in a few remarks on a matter that, collaterally at least, is connected with our subject.

Jos. Scaliger was appointed professor at the university of Leyden in 1593; a date probably not long subsequent to the introduction of porcelain from China by the Portuguese. Indeed, in the very year of his appointment, a rich Portuguese prize from India was brought into London, containing a large quantity of porcelain, which Anderson, in his History of Commerce, considers to be the earliest mention of the importation of that commodity. The beauty of this newly introduced ware appears not only to have turned the heads of the ladies, but to have stimulated the fancy even of grave critics; and Scaliger finding that Propertius describes the murrine cups as having been baked in Parthian furnaces,* and that Martial† talks of sipping hot wine out of them, concludes that they were unquestionably China porcelain. If, however, we turn from the loose assertion of a poet respecting the factitious nature of murrine cups, to Pliny,‡ who as a naturalist was bound to inquire into the matter, we find quite a different representation. "Murrine vases," says this author, "were first brought to Rome by Pompey, in his great triumph over Asia and Pontus. *Unwrought specimens* of murra, and cups made of the same, were dedicated in the temple of Jupiter Capitolinus. This substance soon became the most fashionable and precious of all things at Rome. A cup capable of holding three sextarii (4½ pints) was sold for seventy talents. T. Petronius

* Murreaque in Parthis pocula cocta focis.—*Propert.* iv. 5, 56.

† Si calidum potas, ardenti murra Falerno
Convenit. *Mart.* xiv. 113.

‡ Plinii Hist. Nat. xxvii. 7, 8.

broke, before his death, a murrine dish which had cost 300 talents, lest it should come into the possession of the Emperor Nero. Murra comes from the East: it is found in Parthia, and chiefly in Carmania. Its lustre is without brilliancy; but it is chiefly valuable for its variety of colour, for its spots changing into purple and white, and a colour composed of both these, with a fiery tint: certain spots reflect variable light like the hues of the rainbow. Any translucent or pale parts detract from its value." A talent is equal to about 180*l.* English money; it is obvious, therefore, if single pieces of porcelain were sold at Rome for 70 and 300 talents, or even for one-tenth of the smallest of these sums, that all the crockery shops in Rome would have been blocked up with porcelain in a few years; for the merchants were at this very time carrying on a regular India trade down the Red Sea to the western coast of Hindostan, as far as Ceylon, where they met and dealt with other traders from the countries still farther to the east. But the description of the varying iridescent hues of this substance (to say nothing of unwrought specimens of it) is totally inapplicable to the intricate enamelled patterns of porcelain: and the murra was, in all probability, either the gem called cat's-eye, or perhaps, more likely, one of the iridescent varieties of *adularia*, known among jewellers by the name of moonstone and sunstone, and which come chiefly from Persia, Arabia, and Ceylon.

To return, however, from this digression. The name China, by which the ware that I am about to describe is known in England, shews sufficiently the country from which we have received it. The term porcelain, which is applied to it on the continent of Europe, is Italian; *porcellana* being in that language the name of those

univalve shells forming the genus *cypræa* of the conchologist, which have a high arched back like that of the hog (*porco*, Ital.), and are remarkable for the white, smooth, vitreous glossiness of the surface about the mouth of the shell, and sometimes, as in the common cowry (*Cypræa moneta*), over the whole surface.

The introduction of the Chinese porcelain soon excited a strong desire in the various countries of Europe to imitate it; but as the establishment of experimental manufactories for this purpose required the expenditure of considerable sums, and at a risk beyond the means of private persons, it is chiefly to the munificence of the sovereigns of Europe that the public are indebted for the first steps made in this interesting art. In Germany, chemists and mineralogists were set to work; the latter to seek for the most appropriate raw materials, and the former to purify and to combine them in the most advantageous proportions. The French government adopted the very sensible plan of instructing some of the Jesuit missionaries, who at that time had penetrated to the court of China, and into most of the provinces of that empire, to collect on the spot specimens of the materials employed by the Chinese themselves, together with the particulars of the process. The precise result thus obtained is not known; for as a considerable rivalry existed between the different royal manufactories of this ware, the most valuable information would of course be kept as secret as possible. The most detailed account hitherto given to the public, is that collected by the Père d'Entrecolles, and printed in the *Arts et Métiers* of the Royal Academy of Paris, of which the following is an abstract.

There are three materials employed in forming the

body of the ware, but all the three are never used at once.

The first is called *petuntse:* it contains scattered shining particles, is fine-grained, and is quarried from certain rocks. It is prepared for use by first breaking it with hammers, then grinding it in mortars with iron pestles, and lastly, is washed over, taking only the white creamy matter that floats on the surface, which, after being dried and pressed into small cakes, is fit for use.

The second material is called *kaolin,* and appears to be porcelain clay, namely, that which results from the decomposition of felspar. It is described as occurring in lumps in the clefts of mountains, covered with a reddish earth. It is prepared for use exactly in the same manner as the *petuntse.*

The third material is called *hoaché;* it is used instead of *kaolin.* It has a smooth soapy feel, and no doubt is either steatite, or soapstone, or agalmatolite. It is prepared in the same manner as the preceding. Porcelain made with this latter is much dearer than that made with *kaolin.* It has an exceedingly fine grain and is very light; but, at the same time, is more fragile, and it is not easy to hit on the precise degree of heat that suits it. For the finest porcelain, four parts of *hoaché* are added to one of *petuntse.* Sometimes the body of the ware is made with *kaolin;* and then the article, when dry, is dipped in the *hoaché,* brought to the consistence of cream: what adheres forms a thin layer, on which, when dry, are laid the colours and the glaze; and thus a porcelain finer than the common is obtained. *Hoaché* is also laid with a pencil, before glazing, on those parts of the

common porcelain that are intended to have an ivory white colour.

For the fine *kaolin* porcelains, equal parts of that substance and of *petuntse* are employed; for the less fine, two parts of the former and three of the latter. The ingredients being put together in due proportions, the mass is carefully tempered and kneaded by hand, and then the ware is wrought on the wheel, or, for articles of irregular figure which cannot be thus formed, is made by pressing the composition into moulds, and then uniting the several pieces by moist clay. The piece being formed is very carefully dried, and is then covered with the glaze. The white semi-transparent glaze is thus prepared. The whitest *petuntse* with green spots is pulverised and washed over, as already described; and to 100 parts of the cream thus obtained are added one part of *che-kao* (burnt alum), previously pulverised. A caustic potash ley is also prepared, into which *che-kao* is stirred, and the cream thus produced is collected. The two creams are then mixed together in the proportions of ten measures of the former to one of the latter. This composition it is which gives to porcelain its whiteness and lustre.

A brown glaze is made of common yellow clay, washed over, and brought to the consistence of cream, and then mixed with the former glaze. If the brown glaze is not to cover the whole of the surface, wet paper is laid on the reserved parts, which, after the glaze has been put on and has ceased to be fluid, is removed, and such blank parts are then painted in colours and covered with the common white glaze.

When the glaze is thoroughly dry, the ware is put into the furnace for the first time; whence it appears

that the ware is never in the state of biscuit; a circumstance in which the process materially differs from that adopted by, I believe, all the European manufacturers, who never put on the glaze till after the first firing of the ware.

The flux used with those colours that are laid on over the glaze is made of quartz, calcined and pulverised, and then mixed with cerusse, in the proportion of one of quartz to two of cerusse.

Red is given by peroxide of iron, produced by calcining green vitriol; and a finer red is made of copper, but the particular process is kept secret.

The enamel colours are tempered to the proper consistence by a solution of glue, except those into the composition of which the cerusse enters; these latter are tempered only with water.

Such, in few words, is nearly all that is publicly known of the manufacture of porcelain in China, except the mode of packing the ware in saggars previous to firing, and certain other mechanical details not likely to be of general interest.

On the preceding description I shall hazard a few remarks, being at the same time sensible how likely one not practically acquainted with the manufacture is to fall into error.

In the first place, I think it may be doubted whether the petuntse of the Chinese is a granular quartz or siliceous sandstone, as it is commonly supposed to be. I do not lay much stress on the green spots said to characterise the most valued varieties of this substance, though this colour is of very rare occurrence in sandstones, but by no means uncommon in the porphyritic varieties of compact felspar, so abundant in many parts of North

Wales, and of Cumberland and Westmoreland. In the next place, sandstone, however finely pounded, will not form a cream on the surface of water into which it has been stirred, but will subside almost immediately; whereas, if compact felspar is treated in the same way, the finest of the particles will be brought almost to the state of clay, and will form a cream when stirred with water. That my statement respecting comminuted felspar passing in no great length of time to the state of moderately plastic clay is correct, I may appeal to the experience of every one who has observed how soon the granite fragments which are laid on the streets in London get bound together by a meagre but tenacious clay, formed by the grinding of these stones (of which felspar forms the chief ingredient) by the continued action of carriage-wheels. Thirdly, porcelain clay is of itself scarcely at all fusible, and the addition of 100 or 200 per cent of fine sand to it would make a perfectly opaque body, incapable of undergoing that state of semi-fusion by which alone the true porcelainous texture can be produced. Neither could this substance be formed into a glaze by mixture with burnt alum and precipitated alumina, although the addition of these latter ingredients to the powder of compact felspar would form a composition capable of vitrifying at a high heat into a translucent or semi-opaque enamel. I am therefore inclined to believe that the petuntse is compact felspar, and not sandstone; and that those manufacturers who use calcined flints, or other substances, containing silica almost in a state of purity, as the representative of petuntse, are obliged to add, besides porcelain clay, the other avowed ingredient, some alkaline or vitreous flux, in order to give the ware its due degree of semi-transparency. Such addition, however, cannot

be made without incurring the hazard of lowering too far the infusibility of the porcelain.

All the Chinese porcelains that I have had an opportunity of examining may be reduced to three kinds, as far as regards the body of the ware. The first is that of which the larger pieces of the old blue and white Nankin are formed. Its texture is in general compact, with more or less tendency to fine granular; the fracture surface is even, with a glistening, somewhat resinous lustre; it is translucent at the edges, and has a very pale ochre yellow colour. In order to conceal the colour, it is covered with a white semi-opaque glaze of considerable thickness.

The second differs from the former in having a more compact texture and a white colour. Its glaze is therefore thin and transparent, or nearly so. When the inner surface is left white, as in coffee-cups and other articles of domestic use, no glaze seems to have been applied on that side, it being of itself sufficiently smooth and glossy.

The third kind is lighter than the preceding; it is translucent, has a beautifully even shining surface, but the glaze is so thin as to be scarcely perceptible: it is made only into small articles, and seems to answer well to the hoaché porcelain of D'Entrecolles. All the above varieties are exceedingly infusible, being decidedly superior in this quality to most of the European kinds.

For the specimens on the table we are indebted to Mr. Copland and to Mr. Sidney, members of the Society, the former of whom made his collection of porcelain at Canton. The larger pieces are from the collection of H. R. H. the Duke of Sussex, our president: they were brought to England by Lord Macartney, on his return from his embassy to the court of Pekin.

Of the European manufactories of porcelain, that esta-

blished at Miessen, near Dresden, by Augustus Elector of Saxony and King of Poland, in the early part of the 17th century, was the first that aspired to a competition with the Chinese. In compactness of texture and infusibility it was reckoned perfect a hundred years ago. It is not quite so white as some of the French and English porcelains, but is inferior to none in its painting, gilding, and other decorations. The figures in white biscuit of this ware now before you, belong to a friend of mine, who procured them at Dresden; and the other specimens form part of a set presented to your secretary by the King of Saxony.

The French royal manufactory at Sevrès, near Paris, has been for several years in a gradually advancing state, with regard to the whiteness, compactness, and infusibility of the body, the elegance of the forms, the brilliancy of the colours, the elaborateness of the drawing, and the superb enrichments of the gilding. The private manufactories of porcelain in France imitate and approach more or less near to the royal establishment. Specimens of French porcelain in biscuit, in plain white, glazed, and painted and gilded, are now before you, through the kindness of Mr. Windus, Mr. Pellatt, and Mr. Lemann, members of the Society.

At Berlin and at Vienna are royal porcelain manufactories in high esteem, as well as in some of the smaller states of Germany. For a fine specimen from Hammer, in Bohemia, the Society are indebted to one of its members, Mr. Morrison.

The first manufactories of porcelain in England were those at Bow, and at Chelsea, near London. In these, however, nothing but soft porcelain was made. This was a mixture of white clay and fine white sand from Alum

bay, in the Isle of Wight, to which such a proportion of pounded glass was added as, without causing the ware to soften so as to lose its form, would give it when exposed to a full red heat a semi-transparency resembling that of the fine porcelain of China. The Chelsea ware, besides bearing a very imperfect similarity in body to the Chinese, admitted only of a very fusible lead glaze; and in the taste of its patterns, and in the style of their execution, stood as low perhaps as any on the list. The china works at Derby come, I believe, the next in date; then those of Worcester, established in 1751; and the most modern are those of Coalport, in Shropshire; of the neighbourhood of Newcastle, in Staffordshire, and in other parts of that county.

The porcelain clay used at present in all the English works is obtained in Cornwall, by pounding and washing over the gray disintegrated granite which occurs in several parts of that county: by this means the quartz and mica are got rid of, and the clay resulting from the decomposition of the felspar is procured in the form of a white, somewhat gritty powder. This clay is not fusible by the highest heat of our furnaces, though the felspar, from the decomposition of which it is derived, forms a spongy milk-white glass, or enamel, at a low white heat. But felspar, when decomposed by the percolation of water, while it forms a constituent of granite, loses the potash, which is one of its ingredients to the amount of about 15 per cent, and with it the fusibility that this latter substance imparts.

The siliceous ingredient is calcined flint; and in some of the porcelain works, (particularly, I believe, those at Worcester,) the soapstone from the Lizard-point, in Cornwall, is employed. These are all the avowed materials;

but there is little doubt that the alkalies, or alkaline earths, either pure or in combination, are also used, in order to dispose the other ingredients to assume that state of semi-fusion characteristic of porcelain.

The grinding and due mixture of the ingredients, in order to obtain a mass sufficiently plastic; the forming this mass on the wheel; the subsequent drying of the ware; the first firing, by which it is brought to the state of biscuit; the application of the firmer colours occasionally on the surface of the biscuit; the dipping the biscuit in the glaze; the second firing, by which the glaze is vitrified; the pencilling in of the more tender colours on the surface of the glaze; and the third and last firing that is given to the porcelain,—so nearly resemble the same processes as applied to the more elaborate kinds of earthenware, that it would be a mere anticipation of these latter if I were to describe them now.

It is not for me to determine which of our English porcelains is the best; probably, indeed, one will be found superior in hardness, another in whiteness, a third in the thinness and evenness of the glaze, a fourth in the form of the articles, a fifth in the design, and a sixth in the colours. In hardness and infusibility, they are probably all inferior to the Dresden and to the Sevrès porcelain; for pieces in biscuit and in white glaze, from both these manufactories, are imported in considerable quantities, in order to be painted and finished here. But it is equally certain, that the last ten years have seen the commencement, and, in part, the completion, of such improvements in this fabric, as will probably place the English porcelains on an equality with the best of the continental European ones.

For the specimens of English porcelain now exhibited,

the Society are indebted to the liberality of Mr. Pellatt, Mr. Rose, and Mr. Davenport.

Advantage has recently been taken of the semi-transparency of porcelain biscuit to form it into plates, and to delineate upon it some very beautiful copies of landscapes and other drawings, by so adapting the various thicknesses of the plate as to produce, when held between the eye and the light, the effects of light and shadow in common drawings. The invention originated in the ingenuity of our French neighbours; and some very fine specimens have been sent for exhibition by Mr. Brady.

I now proceed to the last division of my subject, namely, the manufacture of those species of glazed pottery known by the general name of Staffordshire ware.

The date of this ware is about sixty years ago, and it unquestionably originated with the late Mr. Wedgewood. It not only originated with him, but was carried by his knowledge, his skill, and his perseverance, to a degree of excellence which, in several points, has never been surpassed, and in some has never been equalled. With a liberal ambition far above the mere love of gain, his ruling object was to carry the art that he practised to the utmost perfection of which it was capable. For this he spared neither time, nor labour, nor expense; and his splendid success, inciting others to follow in the same track, has secured to his country a most important branch of internal and foreign commerce, and has placed his name for ever among the worthies of the British nation.

He perceived that the defects of the delft ware, at that time the only species of pottery employed for common domestic purposes, were the softness and looseness of texture of its body, which obliged the potter to make it thick and clumsy and heavy, in order to ensure to it a

moderate durability; and that its porousness, as well as its dirty gray colour, required a thick coating of white enamel, which added still farther to its bulk and weight, and which, consisting for the most part of lead and arsenic, was hardly safe for culinary use.

He began, therefore, by inventing a body for earthenware, which at the same time should be white, and capable of enduring a very high degree of heat without fusion, well knowing that the hardness of the ware depended on the high firing to which it has been subjected. For this purpose, rejecting the common clays of his neighbourhood, he sent as far as Dorsetshire and Devonshire for the whiter and purer pipe-clays of those counties. For the siliceous ingredient of his composition he made choice of chalk-flints, calcined and ground to powder.

It might be supposed that white sand would have answered his purpose equally well, and have been cheaper; but, being determined to give the body of his ware as great a degree of compactness as possible, it was necessary that the materials should be reduced to the state almost of an impalpable powder; and calcined flints are much more easily brought to this state by grinding than sand would be. The perfect and equable mixture of these two ingredients being a point of great importance, he did not choose to trust to the ordinary mode of treading them together when moist, but having ground them between stones separately with water to the consistence of cream, he mixed them together in this state by measure, and then, evaporating the superfluous water by boiling in large cisterns, he obtained a composition of the most perfect uniformity in every part. By the combination of these ingredients, in different proportions, and exposed to different degrees of heat, he obtained all the variety of texture

required, from the bibulous ware employed for glazed articles, such as common plates and dishes, to the compact ware not requiring glazing, of which he made mortars and other similar articles. The almost infusible nature of the body allowed him also to employ a thinner and less fusible glaze, that is, one in which no more lead entered than in common flint glass, and therefore incapable of being affected by any articles of food contained or prepared in such vessels. With these materials, either in their natural white or variously coloured—black by manganese, blue by cobalt, brown and buff by iron — he produced imitations of the Etruscan vases, and of various other works of ancient art, such as the world had never before seen — such as no subsequent artist has ever attempted to rival. His copies of the Portland vase, of which the liberality of Mr. Pellatt enables me to lay before you a faultless specimen, are miracles of skill; and the other specimens of similar works, for the exhibition of most of which you are indebted to Mr. Josiah Wedgewood, his son and successor, may give some idea of the many beautiful works that were produced in his manufactory.

In table ware, for many years he led the way almost without a rival; but the immense demand occasioned by the successive improvements of this article, which first put down the use of delft, and then of pewter, gave ample room and encouragement to men of capital and skill to enter the field of profit and competition. Much good has hence resulted: many subordinate improvements have been effected and are almost daily making; and a new variety of ware, called ironstone, has been invented, and so rapidly and judiciously improved, that, in appearance and in many of its intrinsic properties, it bears a close

resemblance to the older and coarser porcelains of China itself.

I shall conclude by a summary account of the manufacture of the best table ware; for a considerable part of which I am indebted to notes taken by Captain Bagnold, when visiting a pottery, inferior, perhaps, to none in the country. For the copious and interesting collection of specimens of almost every variety of Staffordshire table ware, we are under great obligation to Mr. Pellatt and Mr. Davenport.

The materials of the Staffordshire ware are calcined flints and clay. The flints are burnt in kilns, and then, while hot, quenched in water, by which they are cracked through their whole substance. After being quenched they are ground in mills with water. The mill is a hollow cylinder of wood bound with hoops, and having a bottom of blocks of chert, a hard, tough, siliceous stone: the mill-shaft is perpendicular, and has two horizontal arms passing through it cross-wise. Between these arms are laid loose blocks of chert, which are moved round on the bed-stone as the arms revolve, and thus grind the flint with water to the consistence of cream.

The clay, from Dorsetshire and Devonshire, is mixed with water, and in this state is passed through fine sieves to separate the grosser particles. The flint and clay are now mixed by measure, and the mud or cream is passed through a sieve in order to render the mixture more complete.

In this state it is called slip, and is now evaporated to a proper consistence in long brick troughs. It is then tempered in the pug-mill, which is an iron cylinder placed perpendicularly, in which an arbor or shaft revolves, having several knives projecting from it, the edges of

which are somewhat depressed. By the revolution of these the clay is cut or kneaded, and finally is forced by their action through a hole in the bottom of the cylinder, and is now ready for use. Cups, pots, basins, and other round articles, are turned rough on the horizontal potter's wheel, and, when half dried, are again turned in a lathe. They are then fully dried in a stove, and the remaining roughnesses are afterwards removed by friction with coarse paper. Articles that are not round, and the round ones that have embossed designs on their surface, are made of thin sheets of clay rolled out like dough, and then pressed into moulds of plaster of Paris; the moulds being previously dried, absorb the superficial moisture of the clay, and thus allow it to part from them without injury. The two or three separate pieces composing the article are then united by means of fluid slip. Spouts and handles of jugs and tea-pots are made and united with the body of the vessel in the same way. Small handles, beadings, mouldings, &c. are formed by means of an iron cylinder, having its bottom perforated so as to mould the clay, as its passes through, into the required figure. A piston is inserted into the top of the cylinder, and caused to descend slowly by means of a screw, in consequence of which the clay is continually passing out through the perforation, and is cut off in lengths.

Plates are beaten or rolled out of a lump of clay, and are then laid on a mould turned to the shape of the upper surface of the plate. A rotatory motion is given to the mould, and an earthenware tool representing a section of the plate is pressed upon it; thus the plate is made smooth, has a uniform thickness given to it, and it takes a perfect cast of the mould. Cups, saucers, and

basins, when rough-turned, are dried on the block to prevent them from warping.

The ware being thoroughly dried, is packed into saggars and burnt in the furnace to biscuit. Patterns for flat, or nearly flat surfaces, are put on by printing the pattern from a copper-plate with an ink composed of oxide of cobalt, oxide of iron, or other colouring matter, mixed with oil. The impression is taken on soft paper, and is applied to the surface of the biscuit, and slightly rubbed to make the print adhere: the biscuit is then soaked in water till the paper may be stripped off, leaving the print or pattern behind.* The ware is then dipped in the glaze, which is a mixture of flint slip and white lead, and the bibulous quality of the biscuit causes a sufficient quantity to adhere: the piece is then dried and again passed into the furnace, which brings out the colours of the pattern, and at the same time vitrifies the glaze.

The finest patterns are applied after the glazing has been completed, by taking the impressions from the copper-plate on a flexible strap covered with a strong gelatinous mixture of glue and treacle. This strap is then pressed on the ware, and gives the impression in glue, the colouring powder is then dusted over it, and a sufficient portion adheres to the damp parts to give the pattern, after having been again in the furnace. The more elaborate patterns on earthenware, and all those on porcelain, are finished by pencilling in.

* This very ingenious method of transferring printed patterns to biscuit ware was invented at the porcelain works at Worcester.